

**PATENT ABSTRACTS OF JAPAN**

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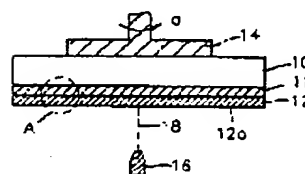
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**(54) DEVELOPMENT OF PHOTSENSITIVE FILM FORMED ON WAFER**

(57)Abstract:

**PROBLEM TO BE SOLVED:** To provide a development method in which neither dissolved photosensitive film particles nor fine residues of a developer and a cleaning solvent remain on a wafer even of the rotating speed of the wafer is reduced.

**SOLUTION:** A wafer 10, in which a material layer 11 for forming a desired pattern and a photosensitive film 12 coated on the layer 11 are formed, is attached to a wafer holder 14 so that the surface of the film 12 faces the ground. Then, a developer 28 is jetted onto the surface of the film 12 using a developer jetting unit 16 to thereby cause the film 12 to react with the developer 28. A cleaning solvent is thereafter jetted onto the surface of the film 12, which has already been jetted with the developer 28, using the cleaning solvent jetting unit 16. The developer jetting step and the cleaning solvent jetting step are performed while the wafer is being rotated.



## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to the manufacture method of a semiconductor device, and relates to the development method of the film formed on the wafer at the detail further.

[0002]

[Description of the Prior Art] Generally, a semiconductor device follows many processes and is manufactured. The photograph process for forming in the pattern of a wish the matter layer formed on such many in-process shell wafers is a process required of manufacture of a semiconductor device indispensable. Such a photograph process includes the development process which develops the photoresist film on the wafer with which the exposure process irradiated alternatively and the aforementioned exposure process completed light like ultraviolet rays to the application process which forms a film, for example, a photoresist film, on a wafer, and the predetermined field of the aforementioned photoresist film, and forms the photoresist pattern of the gestalt of a wish.

[0003] On the other hand, the conventional development process advances, after the front face of the film formed on the wafer has gone upwards. At this time, the film dissolved in the development in-process developer comes to exist as a detailed particle in a developer. In such a conventional development process, removal of the dissolved film particle which exists on a wafer, a developer, and a penetrant remover is carried out by rotating a wafer and making it bounce besides a wafer with a centrifugal force.

[0004] However, if a film front face rotates a wafer in the state where it went upwards in order to remove the film particle, developer, and penetrant remover which exist on a wafer and which were dissolved, the film particle, developer, and penetrant remover which were dissolved in the developer will come to collide with the side attachment wall of a film pattern, being accelerated with a centrifugal force. Thus, the film pattern with a small touch area with a lower film had the trouble which the development which is pushed, falls or is separated from a substrate comes to occur, and cannot fully form the pattern of a wish by applying the force at the side attachment wall of a film pattern, as for the conventional development process.

[0005] Thus, a generating field also becomes still larger and it becomes the cause which increases the percent defective of a semiconductor device, so that it comes to generate especially the trouble that a film pattern is pushed or falls, in large numbers in the limb neighborhood of a wafer and the aperture of a wafer becomes large. At the conventional development process, in order to minimize the trouble by such centrifugal force, the method of decreasing the rotational speed of a wafer is used. When rotational speed is decreased, it becomes impossible however, for the film particle, developer, and penetrant remover which were dissolved to fully bounce to \*\* of a substrate. Therefore, after a development process is completed, the detailed residue of the film particle dissolved on the wafer, a developer, and a penetrant remover will remain, and other troubles come to occur.

[0006] Although aperture of a wafer is made small or there is the method of enlarging pattern size and increasing the touch area of a film pattern and a lower film as other methods for on the other hand minimizing the trouble by such centrifugal force, when it sees from the trend of the present technology in which a semiconductor device is integrated highly and the size of a wafer is diameter[ of a large quantity ]-ized, it is very difficult for this to realize by being an opposite method.

[0007]

[Problem(s) to be Solved by the Invention] The purpose is in offering the development method that the detailed residue of the film particle dissolved on the wafer, a developer, and a penetrant remover does not remain even if it was thought out in order that this invention might solve the above troubles, and it decreases the rotational speed of a wafer.

[0008]

[Means for Solving the Problem] The development method of the film formed on the wafer of this invention for attaining the aforementioned purpose The stage of equipping a wafer electrode holder with the wafer with which it coated, and was exposed and the film was formed on the matter layer for forming the pattern of a wish, and the aforementioned matter layer so that the front face of the aforementioned film may go downward, A developer is injected on the front face of the aforementioned film using a developer fuel injection equipment, and the aforementioned film, the stage of making the aforementioned developer reacting, and the stage that uses a penetrant remover fuel injection equipment for the aforementioned developer and the front face of a film which reacted, and injects a penetrant remover are provided. The aforementioned developer injection stage and the aforementioned penetrant remover injection stage advance in the state where the aforementioned wafer rotates.

[0009] The aforementioned developer fuel injection equipment and the aforementioned penetrant remover fuel injection equipment are the same fuel injection equipment or a respectively different fuel injection equipment, and it deals in them. As for the number of the aforementioned developer fuel injection equipments, and the number of the aforementioned penetrant remover fuel injection equipments, it is desirable that it is plurality, and, as for the aforementioned developer fuel injection equipment and the aforementioned penetrant remover fuel injection equipment, moving along the front face of the aforementioned film is desirable. the reaction time of the aforementioned developer -- it is desirable to add a very small vibration to a wafer for a smooth reaction

[0010] As for the rotational speed of the aforementioned wafer, it is desirable to adjust so that the direction of the composition-of-forces component of the self-weight by the gravity of the detailed particle of the aforementioned film dissolved in the aforementioned development reaction stage, the aforementioned penetrant remover, and the aforementioned developer and the centrifugal force in rotation of a wafer may become in the direction which inclined to the side attachment wall of a film pattern. Before carrying out the aforementioned developer reaction stage, a front rinse stage can be included further first.

[0011] The development method of the film formed on the wafer accompanying this invention can prevent the development of the photoresist pattern according the rotational speed of a wafer to a centrifugal force an outline and since it can be made to decrease by about 1,000 rpm fallen and \*\*\*\*(ed), and can lower the percent defective of a semiconductor device, storing sufficient rinse effect according to the effect by gravity compared with the conventional method.

[0012] Moreover, a desirable result is expectable even if it applies not only to a 8 inch wafer present in use but to a 12 inch wafer. This is a desirable thing when storing sufficient rinse effect takes an example by the trend demanded, making rotational speed of a wafer still lower in the development process according to diameter-ization of a large quantity of a wafer.

[0013]

[Embodiments of the Invention] Hereafter, with reference to the appended drawing, the form of the desirable operation accompanying this invention is explained in detail. As [ interpret / however, / this invention / as being limited to the form of the following operation ] Moreover, it is exaggerated in order that the thickness of a layer, a field, etc. might clarify explanation with a drawing. The same reference mark shows the same component with a drawing.

[0014] Usually, a development process comes to pass through a development stage and a back rinse stage from a front rinse stage. In a front rinse stage, the front face of a film like a photoresist is washed, temperature is adjusted, and the developer breathed out by the development in-process film front face is washed out in a back rinse stage. After the wafer possessing the film coated on the matter layer for forming the pattern of a wish and the aforementioned matter layer follows an exposure process and a front rinse process, a development stage advances. A development stage is divided roughly into a developer \*\*\*\* stage and a development reaction stage.

[0015] In a developer \*\*\*\* stage, a developer is breathed out on the wafer in which the film was formed by fuel injection equipment like a nozzle. At this time, the developer should be breathed out uniformly simultaneous all over the film. In a development reaction stage, the developer

uniformly breathed out on the film in the developer \*\*\*\* stage dissolves alternatively the portion by which the film was exposed. Since a part of film side attachment wall which will not be exposed at this time if a developer comes to be influenced of the physical force comes to react with a developer, as for the portion and developer with which the film was exposed, it is desirable to adjust the rotational speed of a wafer, without being influenced of the physical force, so that a chemical reaction may start purely.

[0016] Between development reaction stages, in order to remove from a wafer the film and developer which were dissolved by reacting with a developer, a wafer comes to pass through a back rinse stage continuously. The film and developer which were dissolved using the penetrant remover injected from a fuel injection equipment like a nozzle are removed from a wafer, and it is made to remove efficiently in a back rinse stage by applying the suitable centrifugal force for the film and developer which were made to rotate a wafer and were dissolved at this time.

[0017] However, it mainly comes to generate the trouble by the already described centrifugal force from a back rinse stage. Therefore, this invention is for improving a back rinse stage and minimizing the trouble by the centrifugal force. Drawing 1 is a schematic diagram for explaining the development method of this invention.

[0018] If drawing 1 is referred to, the wafer 10 with which a matter layer 11 like an oxide film and a film 12 like a photoresist were formed in order will be first installed in the wafer electrode holder 14 which possesses a vacuum chuck. Unlike the conventional method of installing surface 12a of a film 12 upward, at this time, surface 12a of a film 12 is installed downward by the method of this invention. It is for minimizing the trouble by the already explained centrifugal force by receiving the self-weight not only by a centrifugal force but gravity to install surface 12a of a film 12 downward, when the film and developer which were dissolved from the development reaction stage are removed from a wafer. And in order to develop a film 12, a developer is injected toward surface 12a of a film 12 from a fuel injection equipment 16 like a nozzle (developer \*\*\*\* stage). Before passing through the aforementioned developer \*\*\*\* stage, passing through a front rinse stage is desirable.

[0019] After a developer \*\*\*\* stage is carried out, a developer reaction stage advances continuously. At this time, it is desirable to give a detailed vibration to a wafer for a smooth reaction. A developer reaction stage is explained in detail again below. In order to remove from a wafer the film and developer which were dissolved in the developer reaction stage, a penetrant remover 18 is injected toward surface 12a of a film 12 from a fuel injection equipment 16 (back rinse stage). Although only one fuel injection equipment 16 was shown in drawing 1, as shown in drawing 2, penetrant removers 27, 28, and 29 can be injected from two or more fuel injection equipments 26a, 26b, and 26c, and the number of fuel injection equipments can change as occasion demands. Moreover, a developer and a penetrant remover can be injected from the same fuel injection equipment, as shown in drawing 1, and they can also be respectively injected from another fuel injection equipment. Reference numbers 20, 21, and 22 show the matter layer for forming a wafer and the pattern of a wish respectively as well as drawing 1, and a film by drawing 2. Reference-number 22a shows the front face of a film, and a reference number 24 shows a wafer electrode holder. A fuel injection equipment 16, or 26a, 26b and 26c are also movable along the front faces 22a or 22a of a film 12 or a film 22 because of an efficient rinse.

[0020] In the development stage and back rinse stage which consist of a developer \*\*\*\* stage and a developer reaction stage, the wafer 10 or wafer 20 installed in the wafer electrode holder 14 or the wafer electrode holder 24 rotates in a or the direction of b with the equipment (not shown) made to generate rotation like a motor, or rotates to the opposite direction. At this time, the rotational speed of a wafer has a difference bird clapper in a development stage and a back rinse stage. Removing drawing 3 out of a wafer, while the film portion and developer which are the expanded sectional view of A portion of drawing 1, and were dissolved in the developer in the development reaction stage follow a back rinse stage is shown.

[0021] If drawing 3 is referred to, the portion 32 of the film 12 exposed at the exposure process will be dissolved in a developer, and the portion 34 of the film 12 which is not exposed at an exposure process on the contrary will not be dissolved in a developer. The portion 32 of the

dissolved film 12 has come to remain as a detailed particle 36 into the developer. As shown in drawing 3, the development method of this invention is a back rinse stage, and is for such a detailed particle 36, a developer, and a penetrant remover to minimize the influence by the centrifugal force of the particle 36 detailed into the portion 34 (namely, film pattern) of the film 12 which does not remain to a wafer 10 and is not exposed, and a liquid. For this reason, by adjusting the rotational speed of a wafer appropriately and adjusting the detailed particle 36, the self-weight by the gravity of a liquid, and the centrifugal force accompanying rotation of a wafer, it is that a detailed particle 36 and a detailed liquid bounce in c or the direction of d (in namely, direction which is not thrown at the side attachment wall of a film pattern), and enable it to go to it from a wafer 10. At this time, it depends for the rotational speed of a wafer on the degree of adhesion of a film pattern and a lower film (namely, kind of a lower film) depending on the line breadth and the height of the aforementioned film pattern. Although explained to the development process of a positive photoresist above, if it removes that the portion by which a film is not exposed by the case of the development process of a negative photoresist, either is developed, it is the [0022]. [ same ] Next, the example of comparison with the above-mentioned this invention is explained. In order to compare the conventional development method with the development method of this invention, as first shown in drawing 4, two or more 8 inch wafers 40 with which the oxide film 41 and the film 42 were formed in order were prepared, and the exposure process was gone on to the film 42 formed on this 8 inch wafer 40. And according to the conventional development method and the development method of this invention, width of face formed the film pattern whose height is 4,000-10,000Å in the film 42 by which exposure was carried out [ aforementioned ] using a respectively different wafer 40 by 0.15-0.5 micrometers (0.3 micrometers of outlines).

Consequently, when line breadth was 0.3 micrometers or less in the 8 inch wafer 40, the residue with the film particle dissolved in the limb of a wafer 40 at 3,500 or less rpm of outlines when the rinse effect according [ the rotational speed of a wafer 40 ] to a centrifugal force fell, a developer, and a penetrant remover detailed by the conventional development method remained.

[0023] On the other hand, in the case of the development method by this invention, the residue with detailed film particle which the rotational speed of a wafer 40 dissolved in the limb of a wafer 40 also near the outline 2,500rpm, developer, and penetrant remover did not remain. Here, when developing the film formed on the 8 inch wafer and line breadth is 0.3 micrometers, in order to minimize the trouble that a film pattern is pushed by the centrifugal force accompanying rotation of a wafer, or falls with it, the rotational speed of a wafer should make 3,000 or less rpm of outlines.

[0024] therefore, the rotational speed of a 8 inch wafer -- 3,000 or less rpm -- low -- \*\*\*\* -- the development method of this invention which can do things can store sufficient rinse effect, being able to minimize the trouble accompanying a centrifugal force

[0025] Although explained to this invention in the form of the above operation this invention is not limited to the example shown in the form of operation mentioned above. Only, it is provided in order to tell completely those who the form of this operation made the indication of this invention perfect, and had the usual knowledge about the criteria of invention, and it is clear for various deformation and improvement to be possible by those who had the usual knowledge of a field for the time being by the technical thought of this invention and within the limits.

[0026]

[Effect of the Invention] Though sufficient rinse effect stores according to the effect by gravity compared with the conventional method, since the development method of the film formed on the wafer accompanying this invention as having seen above can decrease the rotational speed of a wafer about 1,000 rpm of outlines, it can prevent the development of the photoresist pattern by the centrifugal force fallen and \*\*\*\*(ed), and can reduce the percent defective of a semiconductor device.

[0027] Moreover, a desirable result is expectable even if it applies not only to a 8 inch wafer present in use but to a 12 inch wafer. This can be said to be desirable when storing sufficient rinse effect takes an example by the trend demanded, making rotational speed of a wafer still lower in a development process by diameter-ization of a large quantity of a wafer.

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[Translation done.]

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## CLAIMS

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### [Claim(s)]

[Claim 1] The stage of equipping a wafer electrode holder with the wafer with which the film which was coated on the matter layer for forming the pattern of a wish and the aforementioned matter layer, and was exposed was formed so that the front face of the aforementioned film may go downward, The stage of injecting a developer on the front face of the aforementioned film using a developer fuel injection equipment, and making the aforementioned film and the aforementioned developer reacting to it, It is the development method of the film which possessed the stage which uses a penetrant remover fuel injection equipment for the aforementioned developer and the front face of a film which reacted, and injects a penetrant remover, and was formed on the wafer characterized by the aforementioned developer injection stage and the aforementioned penetrant remover injection stage advancing in the state where the aforementioned wafer rotates.

[Claim 2] The aforementioned developer fuel injection equipment and the aforementioned penetrant remover fuel injection equipment are the development method of the film formed on the wafer according to claim 1 characterized by being the same fuel injection equipment.

[Claim 3] The aforementioned developer fuel injection equipment and the aforementioned penetrant remover fuel injection equipment are the development method of the film formed on the wafer according to claim 1 characterized by being a respectively different fuel injection equipment.

[Claim 4] The number of the aforementioned developer fuel injection equipments is the development method of the film formed on the wafer according to claim 1 characterized by being plurality.

[Claim 5] The number of the aforementioned penetrant remover fuel injection equipments is the development method of the film formed on the wafer according to claim 1 characterized by being plurality.

[Claim 6] The aforementioned developer fuel injection equipment is the development method of the film formed on the wafer according to claim 1 characterized by moving along the front face of the aforementioned film.

[Claim 7] The aforementioned penetrant remover fuel injection equipment is the development method of the film formed on the wafer according to claim 1 characterized by moving along the front face of the aforementioned film.

[Claim 8] The development method of the film formed on the wafer according to claim 1 characterized by adding a very small vibration to the reaction time wafer of the aforementioned developer.

[Claim 9] the rotational speed of the aforementioned wafer be the development method of the film formed on the wafer according to claim 1 characterize by to adjust so that the direction of the composition of forces component of the self-weight by the gravity of the detailed particle of the aforementioned film dissolved in the aforementioned development reaction stage , the aforementioned penetrant remover , and the aforementioned developer and the centrifugal force in rotation of a wafer may become in the direction which inclined to the side attachment wall of a film pattern .

[Claim 10] The development method of the film formed on the wafer according to claim 1 characterized by including a front rinse stage further first before carrying out the aforementioned developer reaction stage.

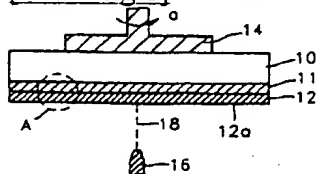
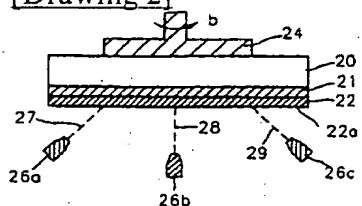
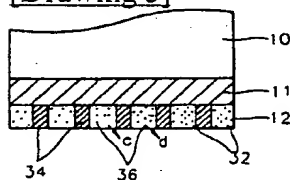
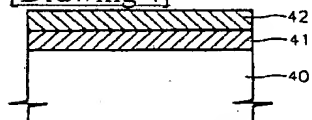
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**DRAWINGS**

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**[Drawing 1]****[Drawing 2]****[Drawing 3]****[Drawing 4]**

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